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THE CARNEGIE INSTITUTION OF WASHINGTON[1]

WHEN the armistice was agreed to by the contending nations in November, 1918, the Institution had become more of an agency for the promotion of warfare than one for the promotion of peaceful pursuits. About two thirds of the staffs connected directly with the Institution, or somewhat more than 200 men, were engaged in war work, and about the same proportion applies to the Research Associates of the Institution and their collaborators. Nearly every expert of the institution was able to render assistance and many of them devoted their entire time and energies to government work. Of the larger undertakings in this work, the most conspicuous are the development to the point of quantity production of the optical glass industry by the Geophysical Laboratory; the manufacture of precision micrometers for the U. S. Bureau of Standards and the manufacture of optical adjuncts for artillery by the staff of the Mount Wilson Observatory; the construction of special devices for the Navy in the shops of the Department of Terrestrial Magnetism; the contributions of the Nutrition Laboratory to knowledge of the effects of undernutrition; and the information service rendered by the Department of Historical Research. These undertakings required many men in arduous researches and involved no inconsiderable costs to the institution, since it assumed, in most cases, the principal overhead expenses. Not less important relatively than these larger operations were many special and individual contributions to the general cause. That essential occupations were quickly developed for what are sometimes called "narrow specialists" in nearly every branch of learning cultivated by

[1] From the report of the president, Dr. R. S. Woodward, for the year ending October 31, 1919.

the institution affords striking evidence at once of the diversity of modern warfare and of the ultimate practical value of recondite researches.

Although formal requests from the government for services ceased nominally toward the close of the calendar year 1918, they actually continued until nearly the middle of 1919. Thus, the optical work and the researches on the concentration of nitrates for the War Department did not end until June, 1919; the information work of the Department of Historical Research continued until mid-July; some special work for the Navy was done by the Department of Terrestrial Magnetism as late as September of this year; while a few other relations in government undertakings still remain to be served. It is only recently, also, that members of the institution in the military and other services of the government have returned to their posts; so that emergence from the untoward conditions in which we find ourselves has only fairly begun.

Naturally, this deflection of interest from the normal activities of the institution has led to many changes, to some dislocations, and to the suspension, or even abandonment, of a number of projects. The war, in fact, has brought some sinister consequences to the institution as well as to most other organizations. Fortunately, of those who entered the military and naval service only two lives were lost, namely, Karl Edward Anderson and Billings Theophilus Avery, both of the Department of Experimental Evolution, who died during the year 1918. Fortunately, likewise, while some members of the investigatory staffs of the departments of research have been drawn off, by reason of their abilities, into industrial or other occupations, the number of such is not only small but not in excess of an inevitable and healthy exchange between a progressive establishment and its contemporaries.

Detailed reports concerning the war activities of the institution, and particularly concerning the work done by the departments of research, are on file in the office of administration; so that if it should become necessary to publish an account of these activities the essential data are at hand. The time for publication of such an account does not appear to have arrived, since the government is entitled to initiative and priority in all these matters.[2] Hence only the briefest references to them are made in this and other parts of the current Year Book.

It should go without saying that the disturbed conditions, social, industrial, economic and governmental, under which the world is now laboring are not without untoward effects on the institution. Being a part of and not apart from contemporary life, it must share to a greater or less extent in the consequences which follow from an unparalleled attempt at national supremacy based on the desperate doctrine of "dominance or downfall." But obvious as these consequences are in the abstract, there appear to be many outside and some within the institution who think that it may continue to expand regardless of the limits of its income and regardless of the fact that the purchasing capacity of this income has diminished by one half during the past decade. In line with these vagaries there is a recrudescence also of the juvenile notion so commonly held of the institution in its earlier years, that it may play the rôle of paternalism for other establishments and for individuals, and that it may act generally as a salvager in the wreckage of the world. Similarly, just as in political affairs it is often assumed that the prevailing scarcity of necessities and the burdens of taxation may be relieved by other means than by productive labor, so it is assumed that the institution may meet the increasing costs of its operations, not by appropriate restrictions and economies, but by increasing appropriations drawn from mythical sources. Thus the distribution of necessary disappointment, which has been so large a part of the unproductive business of the administrative office hitherto, is now increasing, stimulated by two generations of men unaccustomed to the practise of

[2] A concise history of the production of optical glass is given by Dr. Fred E. Wright (major, Engineer Corps, U. S. A.), of the staff of the Geophysical Laboratory, in "America's Munitions," published by the War Department in 1919.

thrift and justified by the widely prevalent but immoral theory that the institution may proceed "regardless of expense."

THE HOOKER TELESCOPE

One of the distinct, if relatively unimportant, misfortunes of the world war was the delay in testing the capacities of the 100-inch telescope named after Mr. John D. Hooker, of Los Angeles, who made the initial contribution toward the construction of this instrument thirteen years ago. It was substantially completed shortly before the United States became a participant in the conflict. About this time, also, the director of the Observatory became chairman of the National Research Council and he continued to give all his time to this governmental organization until May of this year. In the meantime, likewise, as already indicated, the staff of the observatory was preoccupied largely with military rather than with astronomical affairs. Hence, opportunity has only recently arrived for determination of the critical question whether this "largest telescope," which is 28 inches larger than its largest predecessor, and 40 inches larger than the highly successful 60-inch instrument completed by the observatory in 1908, would meet expectations in optical capacity and practicability of operation. The construction of so large a telescope has been regarded as one of the hazardous undertakings of the institution. Its optical perfection depends on the stability of the glass used for its mirror; the stability of the latter depends in turn on the rigidity of its mountings; the requisites in both cases must take into account the elastic mobility of materials and the disturbing effects on them of temperature changes; and all these considerations must unite to secure a combination which is manageable. The problems in engineering thus presented have appealed very strongly to all parties interested in such constructions, perhaps almost as strongly as the astronomical possibilities anticipated from such an extensive addition to visual apparatus. But the director of the observatory now reports that the optical and the engineering difficulties have been overcome and that the instrument under repeated tests has proved efficient quite beyond the conservative theoretical predictions of attainable capacities.

THE NON-MAGNETIC SHIP

As related in the report of the preceding year, it was deemed expedient, in April, 1917, on account of dangers to navigation, to suspend the cruise contemplated by the Department of Terrestrial Magnetism for additional surveys in the Atlantic Ocean by the ship *Carnegie*. As related also in that report, this ship was brought safely, by way of the Pacific Ocean and the Panama Canal, to the port of Washington, District of Columbia, arriving there June 10, 1918. She lay here until the spring of 1919, when it was decided to send her out again on her mission as soon as necessary repairs and alterations could be made. Of the alterations required, the most important was the adaptation of her engine for auxiliary propulsion to the use of gasolene as fuel. When the ship was launched, in 1909, it was easier to get anthracite coal than gasolene or other liquid fuel in remote parts of the world. Hence the engine was constructed to use gas derived from such coal by the so-called producer process. In the meantime, anthracite coal has become much less and gasolene much more accessible at distant seaports, and this circumstance has led to the noteworthy, and in these times expensive, but highly advantageous change here specially referred to. After delays which serve to emphasize the inefficiency of mankind under post-war conditions, on October 19, the *Carnegie*, under the command of Mr. J. P. Ault, put to sea from the Virginia Capes, on her sixth cruise, to comprise surveys in the Atlantic and Indian Oceans not yet adequately covered by previous circuits.

PUBLICATIONS OF THE YEAR

Of all branches of the institution the one least affected by the war is the Division of Publications. Although it has undergone some changes in staff and encountered the obstacles due to a rapid rise in the costs of printing and illustrations, its work has gone

on without serious interruption; and the output of books for the year, as may be seen by reference to the detailed list given in a later section of this report, is rather greater than the average annual output for the past decade. Of the entire list of twenty-nine volumes issued, only two classes of them, selected mainly for the purpose of showing trends of progress, may be referred to here.

The most elementary, the most essential, and hence the most widely used, if not esteemed, of the sciences is arithmetic. It is a fundamental requisite, in fact, of all exact knowledge. Ability to add, subtract, multiply, and divide affords probably the simplest test of capacity for correct thinking. Conversely, inability or indisposition to make use of these simple operations affords one of the surest tests of mental deficiency, as witnessed, for example, by numerous correspondents who are unable to or who refuse to apply these operations to the finances of the institution. But the familiar science of arithmetic lies at the foundation also of a much larger and a far more complex structure called the theory of numbers. This theory has been cultivated by many of the most acute thinkers of ancient and modern times. It has more points of contact with quantitative knowledge in general than any other theory except the theory of the differential and integral calculus. These two theories are complementary, the first dealing with discrete or discontinuous numbers and the second with fluent or continuous numbers. Naturally, a subject which has attracted the attention of nearly all of the great mathematicians of the past twenty centuries has accumulated a considerable history. The more elementary contributions of Euclid, Diophantus, and others of the Greek school; the extensions of Fermat, Pascal, Euler, Newton, Bernoulli and many others in the seventeenth and the eighteenth centuries; and the work of Lagrange, Laplace, Gauss, and their numerous contemporaries and successors of the nineteenth century, make up an aggregate which has stood hitherto in need of clear chronological tabulation and exposition. This laborious task was undertaken about ten years ago by a Research Association of the Institution, Professor Leonard E. Dickson, of the University of Chicago. A publication under the title "History of the Theory of Numbers" has resulted, and Volume I. (8vo, xii + 486 pp.), devoted to divisibility and to primality of numbers, has appeared during the past year; and a second volume devoted to diophantine analysis is now in press. This work is remarkable for its condensation of statement. It contains more information per unit area than any other work issued thus far by the institution. It is remarkable also for the care taken by the author and by his collaborators to secure precision and correctness, a number of experts having assisted in the arduous labors of verification required during the process of printing.

It is the object of science primarily to find answers to the question "How?" rather than to the question "Why?"; or, to seek to describe phenomena rather than to try to explain them. Words, however, constitute, in general, a rather imperfect medium for the communication of ideas, and as a consequence the intellectual world, like the political world, often finds itself involved in misunderstandings which lead to nothing better than that metaphorical and degenerate form of energy called the heat of controversy. Thus, about a half-century ago there arose, as we now see, a quite needlessly bitter discussion over the question whether and to what extent the phenomena of life may be traced back to the properties of matter with which they are obviously intimately associated. The new science of biology was just then arising and the limitations of its domain and the conditions of its existence and development were widely disputed, as is best shown probably by the lay sermon of Huxley delivered at Edinburgh November 8, 1868, "On the Physical Basis of Life." In this remarkable address Huxley defines, with prophetic clearness and completeness, the limitations and the conditions in question and these, as he defined them, are now generally admitted as essential to all fruitful inquiry. Moreover, the principles expounded by Huxley have been justified in amplest measure by the extraordinary

progress since accomplished, not only in biology, but in all the physical sciences.

It is good fortune for a research establishment to have been founded during the course of this progress and to be able to take part in it; and although the publications of the institution are not restricted to any domain of learning, a considerable number of them bear directly or indirectly on this profoundly interesting and increasingly important problem of "the physical basis of life." The past year has been unusually productive in this line, for no less than a dozen volumes have been added to the institution's series of contributions to evolution, heredity, and the application of thermodynamics to the interpretation of metabolism in man. These contributions are particularly noteworthy also for the extent to which cooperation has been required, since more than twenty authors and more than twice that number of collaborators are represented in the dozen volumes referred to.

THE SIGNIFICANCE OF THE DECLINING BIRTH-RATE —A REPLY[1]

MEMBERS of Section I in attendance at the meeting last year will recall the address of the retiring vice-president and chairman of the section. This meeting offers a suitable opportunity to present at least one of the replies which such an address might be expected to call forth.

Seventy per cent. of Mr. Dublin's paper was occupied with statistics, and these we may accept as coming from an expert statistician. It is the remaining thirty per cent.—embodying the author's view of the *significance* of the declining birth-rate—that invites attention.

To begin with, I hardly need point out the necessity of recognizing the prevalence of multiple and compound causes in all fields of social phenomena. When a compound cause has been disentangled from a mass of observations its individual factors must be carefully weighted in order to give proper prominence to the chief one. Mr. Dublin arraigns the women and their education for the declining birth-rate. In so doing he involves himself in a significant concession; and one wonders how, with so much of a clue, he has failed to perceive the true interpretation of the social feature which he deplores. He has fixed his attention on very minor and limited causes only to lose sight of the great generic cause.

For we are to-day in the midst of a revolution quite unparalleled in the history of the human race—whether it be viewed as regards the number of persons concerned, or the length of its preparatory prelude, or the importance of the consequences which will undoubtedly follow it. I refer to the movement connected with the discovery that women, in spite of being females, are primarily human beings, with the same desires for freedom and self-direction, the same ranges in tastes and abilities and ambitions, that men have. This discovery is due to woman's recently acquired opportunity for knowledge and opportunity for economic self-dependence. These opportunities themselves seem to be involved first as effects and then as causes in modern human progress. The evolution of society—civilization itself—had proceeded as far as it could, with the archaic status of woman unmodified.

Folklore and literature from earliest times to very recent days have been charged with positive expressions of the place and duty of the female. Radical writers and conservative ones alike, teachers, philosophers, statesmen and poets, have—with few exceptions—been agreed that that place was home and that duty the care of the home and the rearing of children. Very naturally all schemes of government and all systems of theology have been in harmony with this popular conviction. To cook a thousand meals a year, to make beds and wash dishes a thousand times a year, to bear children—always to bear children—in meekness and resignation, has been held to be the woman's lot as ordered by Providence or at least by Nature. What else could a normal woman want to do?

[1] Read before Section I (Social and Economic Science) of the American Association for the Advancement of Science, Baltimore, December 27, 1918.